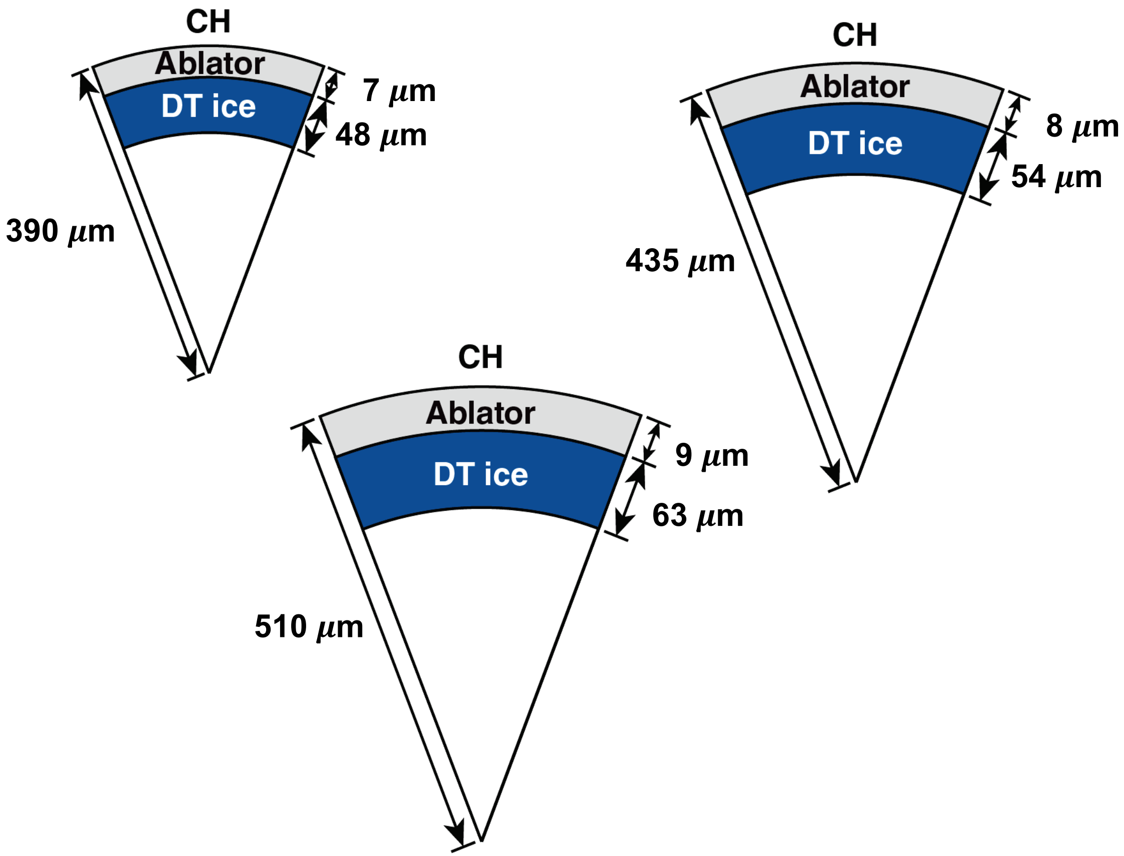
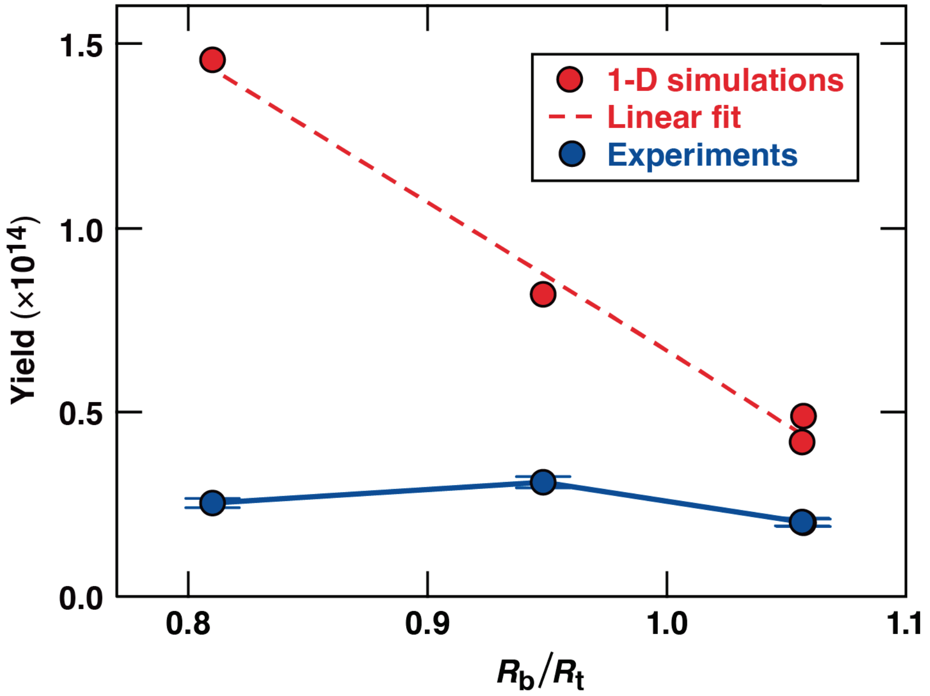
Experiments to Study the Impact of the Beam-to-Target Ratio in Direct-Drive DT Cryogenic Implosions on OMEGA





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The losses in performance due to hydro-instabilities balance the gains from higher laser absorption and energy at small beam-to-target ratios

- Designs with a smaller beam-to-target ratio (R_b/R_t) are expected to show higher laser absorption, but are susceptible to degradation due to irradiation nonuniformities
- Targets with three different diameters were irradiated with laser pulses designed to keep the implosion dynamics comparable at constant irradiation intensity (~6.5×10^{14} W/cm^2)
- Multidimensional simulations taking to account only low modes like beam port geometry fail to reproduce the experimental trends
- After adding the effects of laser imprint the multidimensional simulations reproduce the experimental trends reasonably well

Collaborators

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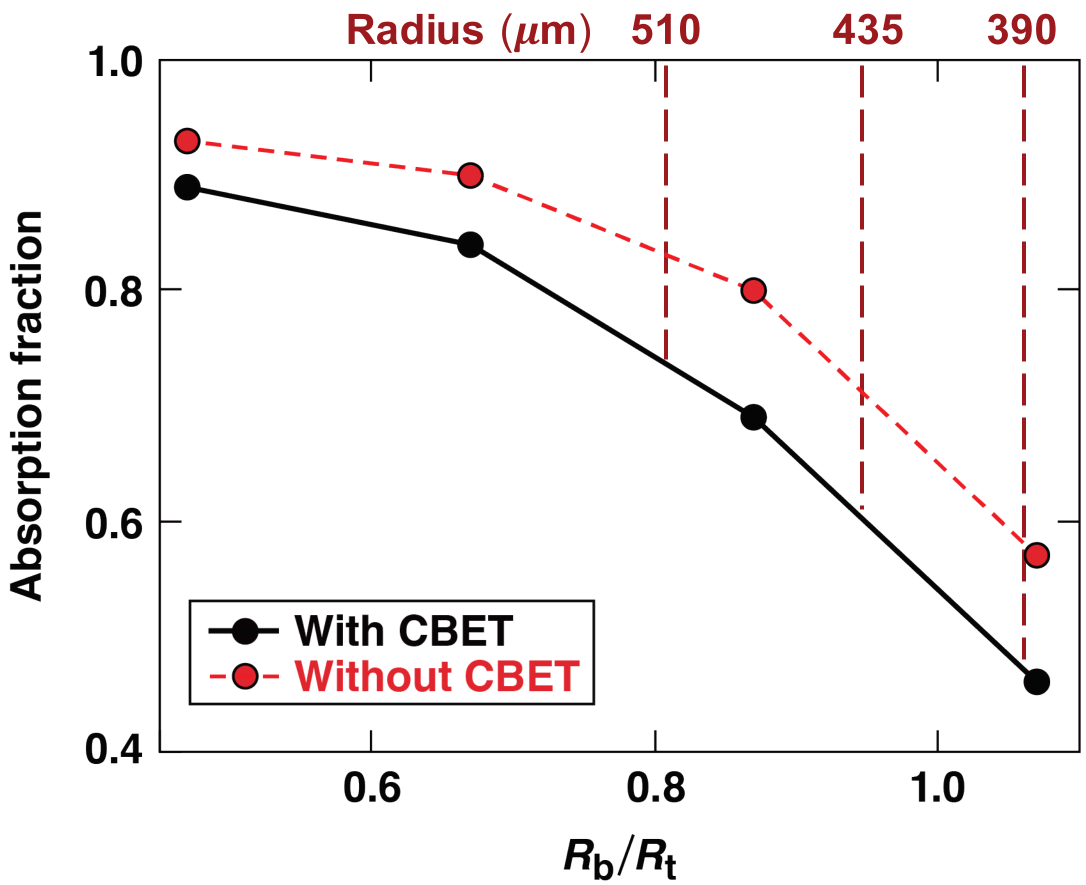
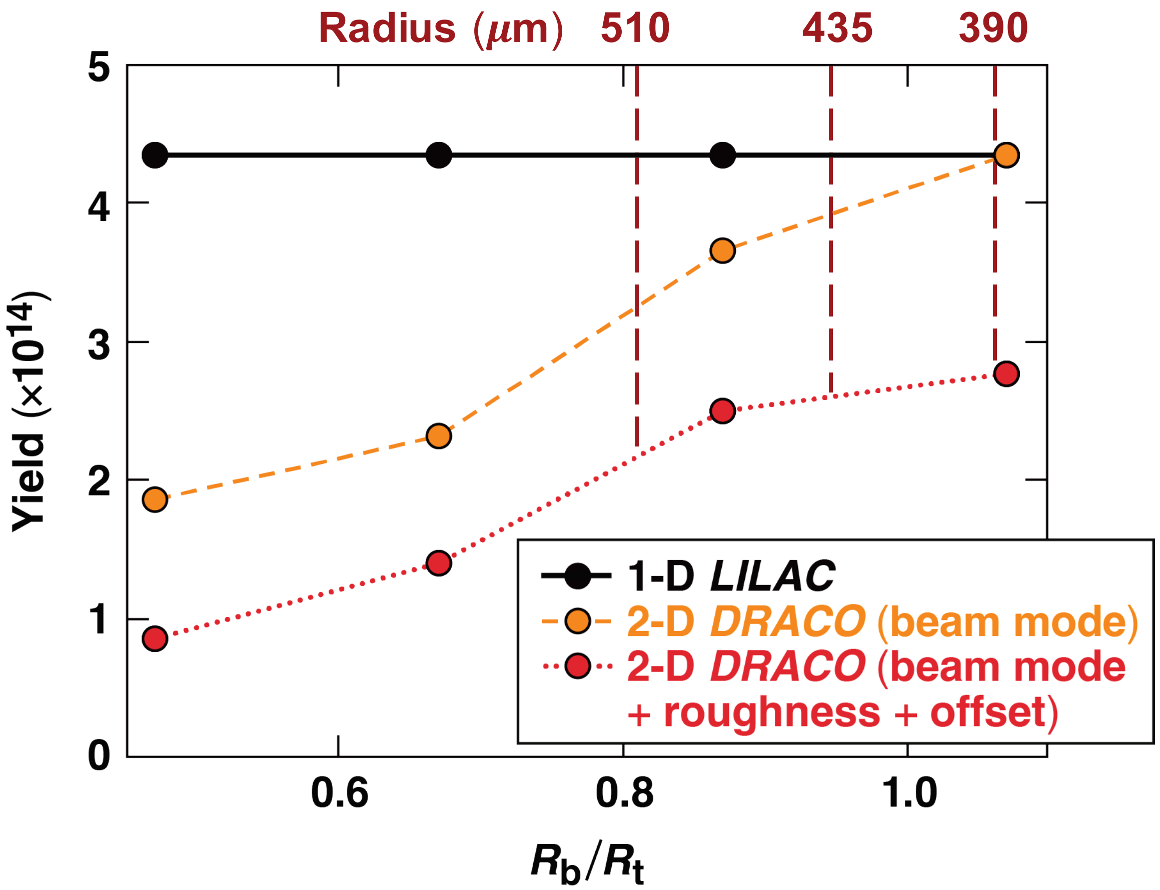
Designs with a smaller beam to target ratio show higher laser absorption, but are susceptible to degradation due to irradiation non-uniformities





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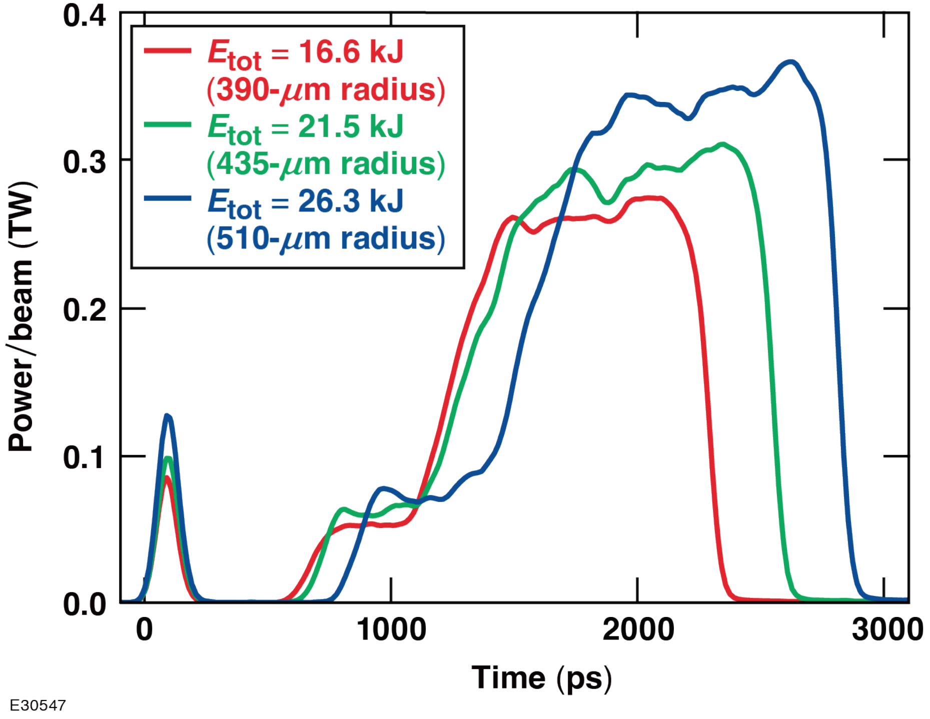
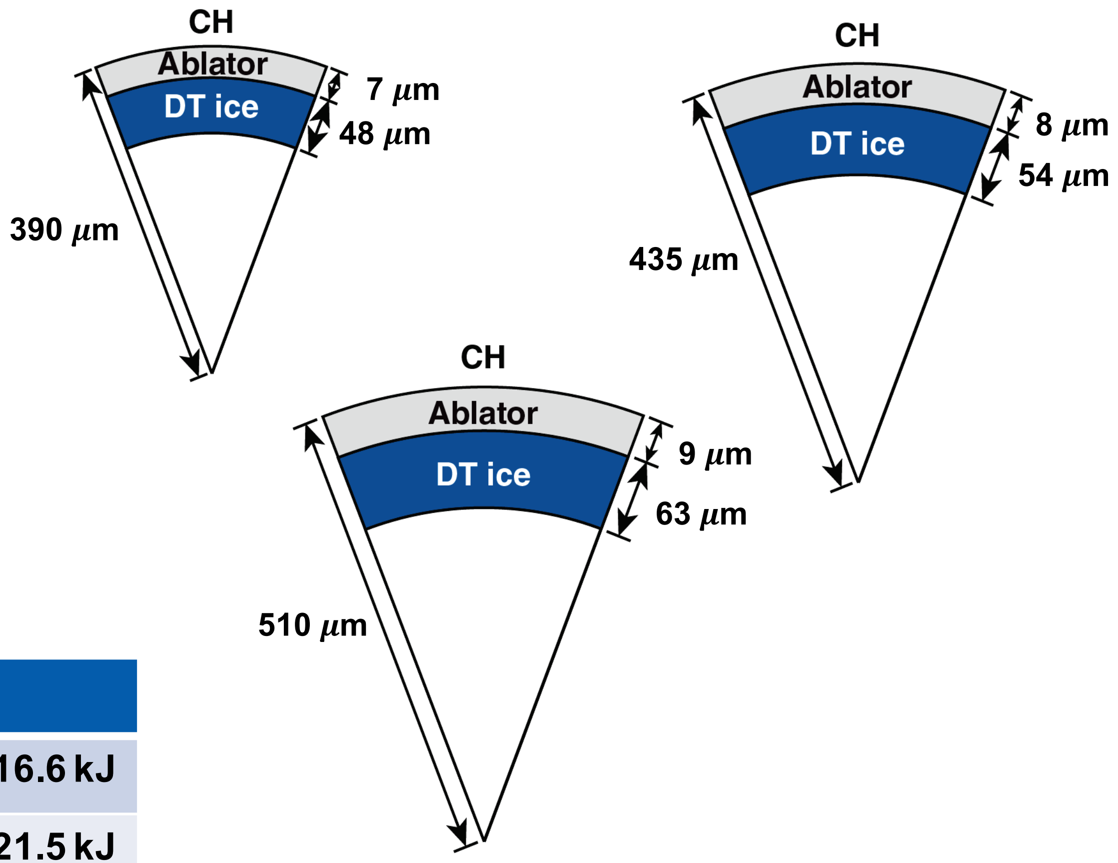
CBET: cross-beam energy transfer

LILAC: 1-D radiation hydrocode; J. Delettrez *et al.*, Phys. Rev. A 36, 3926 (1987).

DRACO: 2-D radiation hydrocode; P. B. Radha *et al.*, Phys. Plasmas 12, 032702 (2005).

The laser pulse shape was designed to keep the implosion dynamics for all three targets comparable at constant irradiation intensity (~6.5×10^{14} W/cm^2)

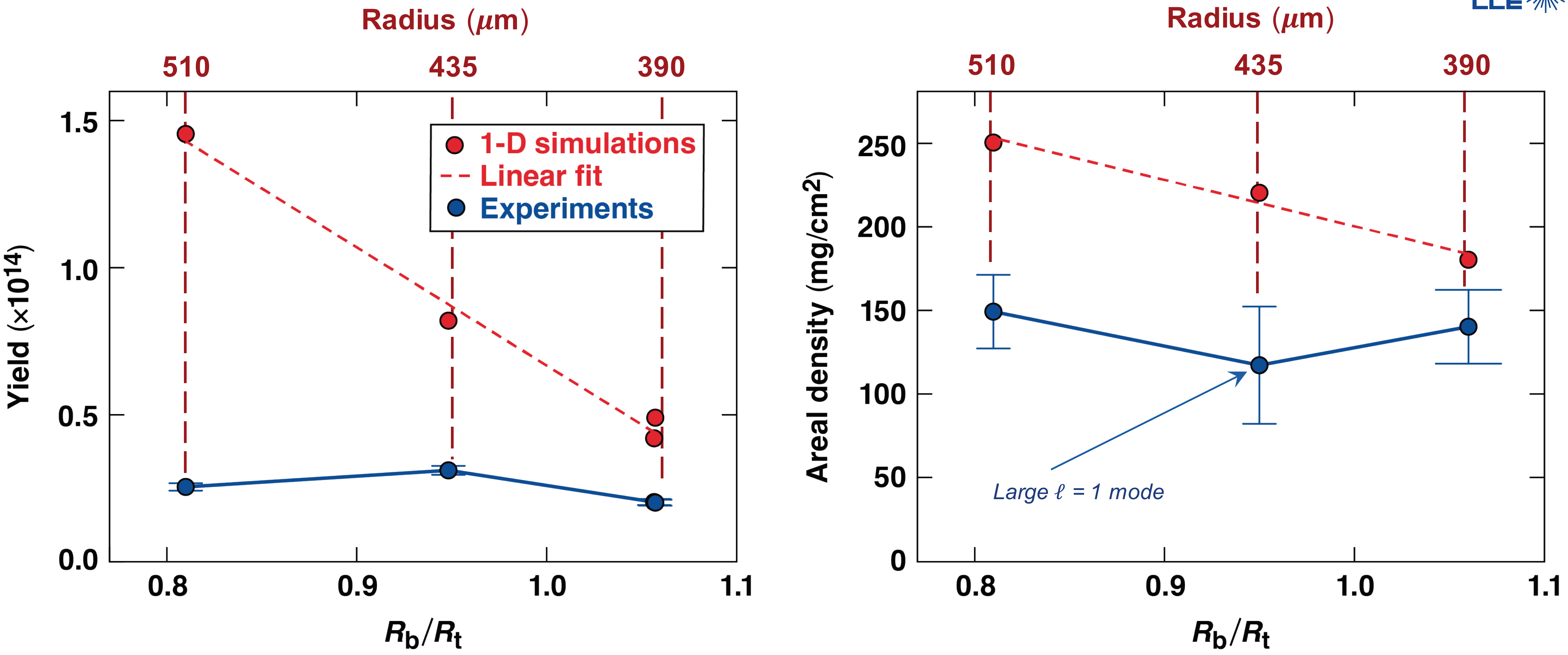




Values from 1-D *LILAC* simulations				
390-μm radius	v = 335 km/s	adiabat = 2.8	IFAR = 24.7	E = 16.6 kJ
435-μm radius	v = 335 km/s	adiabat = 2.8	IFAR = 22.9	E = 21.5 kJ
510-μm radius	v = 333 km/s	adiabat = 2.6	IFAR = 24.6	E = 26.2 kJ

IFAR: in-flight aspect ratio
adiabat: internal energy/Fermi energy
v: peak implosion velocity

Experiments at smaller beam-to-target radius (R_b/R_t) are significantly further from expectations based on 1-D simulations



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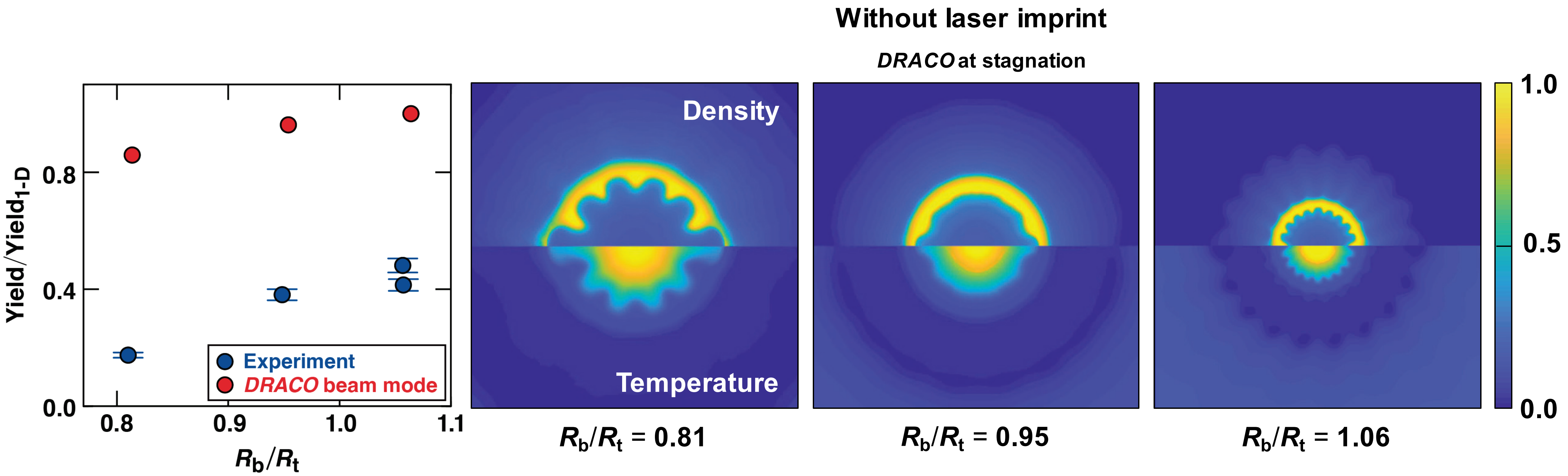
*Data are corrected for fuel age and mode 1**

*A. Lees *et al*., Phys. Rev. Lett. 127, 105001 (2021).

Low-mode calculations in *DRACO* can be used to account for port geometry and modes 1 to 10, but do not explain observations

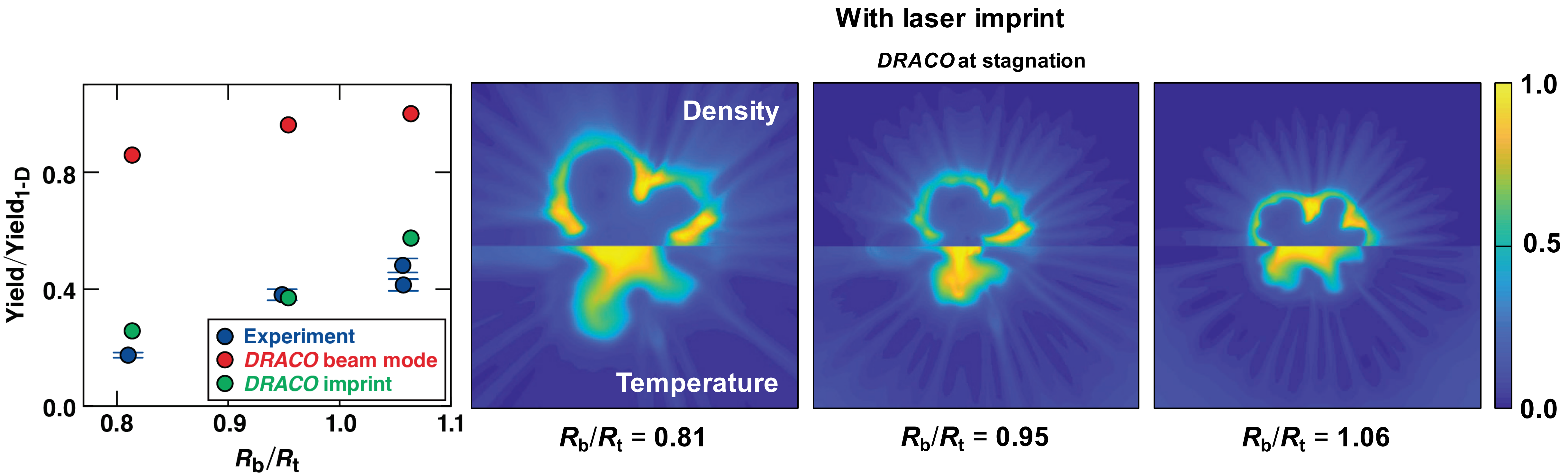


E30549

DRACO:

- 2-D axisymmetric mesh, 3-D laser ray trace
- Cross-beam energy transfer + nonlocal heat conduction
- Beam overlap of 60 beams on target included
- Resolves modes 1 to 50 (no speckles from imprint)

DRACO attributes the apparent sensitivity almost entirely to imprint; R_b/R_t changes the beam overlap and the averaging of speckles

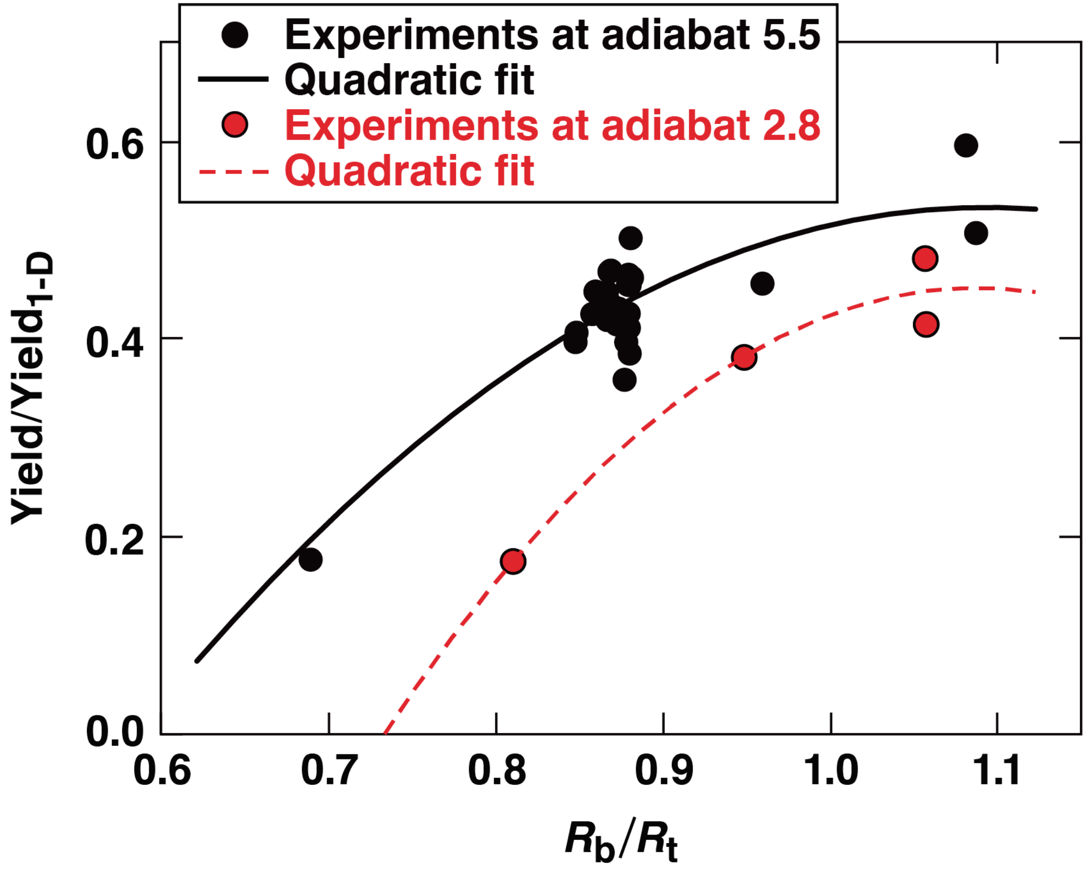


E30550

DRACO:

- 2-D axisymmetric mesh, 3-D laser ray trace
- Cross-beam energy transfer + nonlocal heat conduction
- Beam overlap of 60 beams on target included
- Resolves modes 1 to 50 (includes speckles from imprint)

The shape of yield versus R_b/R_t is qualitatively similar for high- and low-adiabat shots, but low-adiabat shots do appear to be more sensitive



E30551

The losses in performance due to hydro-instabilities balance the gains from higher laser absorption and energy at small beam-to-target ratios

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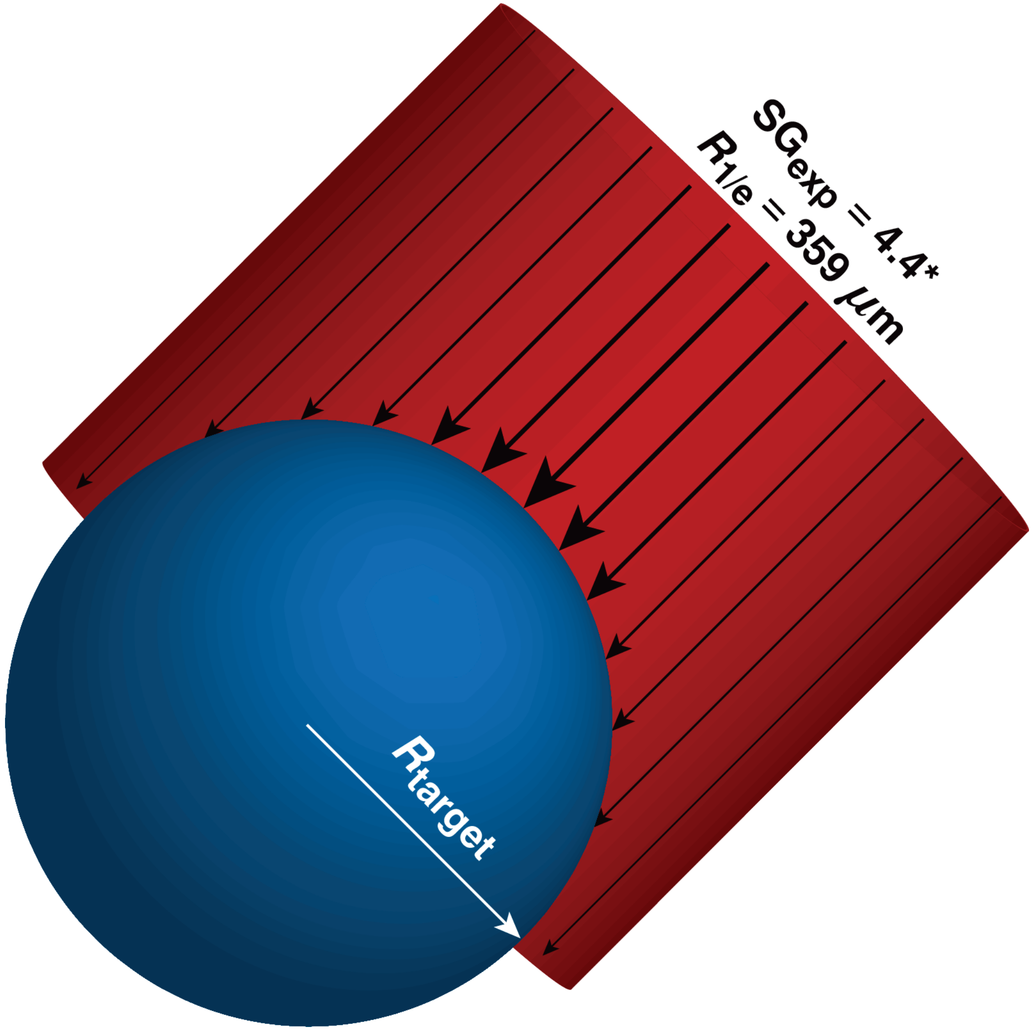
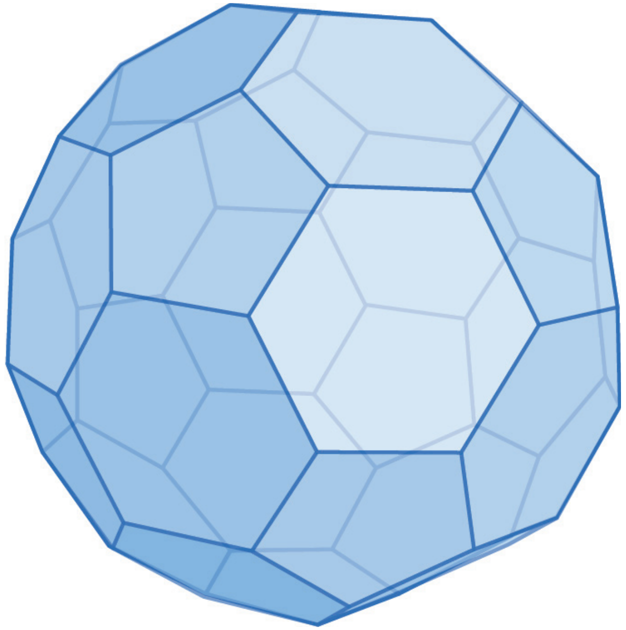
Backup

The on-target intensity distribution is calculated by overlapping all 60 beams onto a sphere





- **OMEGA beam port illumination**

*From analysis by A. Shvydky